CHAPTER 4

IMPACTS TO BIRDS CAUSED BY WIND ENERGY GENERATION

4.1 INTRODUCTION

Bird mortality studies reporting on wind energy facilities elsewhere regularly report that bird mortality in the APWRA is unusually high there and is, therefore, an anomaly among wind energy facilities in the United States. We found that recent published comparisons of mortality estimates between different facilities relied solely on mortality estimates between the different facilities, but they failed to incorporate bird abundance at those facilities in their comparisons (e.g., Erickson et al. 2001). The argument is often put forth that because most potential wind energy generating facilities in the United States lack the number of raptors that occur in the APWRA, raptor mortality can be expected to be less significant at new sites, and that raptor mortality in the APWRA is not indicative of mortality nationally. We reexamine whether this characterization of the APWRA is accurate, using data for bird use and mortality.

Mortality is only one measure of impact. Bird mortality at energy generating facilities can also be measured relative to the abundance of the species occurring at the facilities. For example, if the habitat area of the wind farm supported only one pair of red-tailed hawks, and a wind turbine killed one or both of that pair, then the wind farm would have had a significant adverse impact on that species within the area of the wind farm. Some locations are inherently less productive for particular bird species, and so these species occur there more rarely. Rarity is not a condition that guarantees impacts will be less significant, and in some cases rarity is a condition that should heighten concern for the facility-caused loss of birds. In this chapter, we will not assess the site-specific significance of rarity in the mortality of birds, but we will synthesize the estimates of mortality that are also accompanied by estimates of relative abundance.

4.2 METHODS

We reviewed published reports of bird mortality at wind energy facilities, and we extracted from those reports the mortality estimates and associated attributes of the study. Studies from which we collected mortality estimates and related data included Howell (1997), Howell and DiDonato (1991), Howell et al. (1991), Howell and Noone (1992), Orloff and Flannery (1992), Kerlinger (2000), Howe (2001) (c.f., in Erickson et al. 2001), Strickland et al. (2001a,b), Thelander and Rugge (2001), Johnson et al. (2002), Erickson et al. 2003, Anderson et al. (in review, a; in review, b), and Smallwood and Thelander (2004). Data were also collected from Janss and Clave (2000) and Winkelman (1989, 1992), but not used in the analyses reported herein because they involved wind farms in Europe.

The extracted data were organized into a spreadsheet for synthesis. We recorded whether the mortality estimate was based on raw numbers of fatalities or whether they were adjusted by scavenging rates, detection bias, or other factors, and we recorded whether the estimate included only fatalities caused by wind turbine collisions or whether they included all fatalities caused by all facilities and human activities at the wind farm. We recorded the number and types of wind turbines used to generate the estimates, as well as the span of time used for monitoring for bird carcasses. We also recorded the carcass search radius, scavenging rates, searcher detection rates, and search interval in days. Site location was recorded along with the year of the estimate. Multi-annual studies were represented by the middle year when annual estimates were not provided.

For the purpose of comparing estimates among project sites, we needed to standardize the mortality estimates to the extent possible. For example, because we found 11.2% of the bird carcasses outside our 50-m search radius in the APWRA, and because our sample of bird fatalities was larger than recorded at any other wind energy facility or related study, we relied on our rates of carcass detection within distance intervals from the wind turbines to adjust the mortality estimates reported in the other studies we reviewed. For example, Orloff and Flannery (1992) searched out to 30.7 to 61.4 m from wind turbines, and within 30.7 m we found 68.6% of all our bird carcasses and 65.6% of all our raptor carcasses. We assume that Orloff and Flannery would have missed up to 34.4% of the raptor carcasses and 31.4% of all the bird carcasses that we found. Additionally, we assume that we missed half the carcasses beyond our 50-m search radius, and that Orloff and Flannery would have missed these also (our only basis for this assumption is experience in the field, and so represents our professional judgment). Adding in our assumed error rate translates to Orloff and Flannery's finding of 57.4% of all bird carcasses found within 30.7 m and 51.4% of all raptor carcasses found, all other factors not considered. Therefore, we adjusted Orloff and Flannery's mortality estimates by dividing them by 0.574 for all birds and 0.514 for raptors.

For each reported search radius equal or larger to 50 m, we identified the proportion of bird carcasses we found beyond that radius and multiplied it by two (again, assuming a 50% miss rate). This product was divided into the reported mortality estimate. We did not adjust reported mortality estimates by scavenging rates, searcher detection rates, or search intervals because these attributes were too scant in the literature to be useful at this time. In some cases, mortality estimates were already adjusted by these factors, but in most cases they were not. The reported scavenging rates were reported in two formats: (1) percent of carcasses remaining after so many days, and (2) the number of days until all carcasses were removed. The use of both formats among research reports was an inconsistency that prevented reliable adjustments for scavenging in our synthesis. Search intervals were usually reported, but we could not adjust the mortality estimate by this factor without within-study reporting of the variation in mortality due to variation in search interval.

4.3 RESULTS

Bird mortality correlated significantly with the number of birds observed per hour during point counts (Figure 4-1). It did not correlate significantly with the carcass search interval in days, the radius of the search around the wind turbine, the years spanning the searches for carcasses, and the number of megawatts generated by the wind turbines that were sampled. Raptor mortality also correlated significantly with the number of birds observed per hour during point counts (Figure 4-2), but not with the number of raptors observed per hour, nor with the carcass search interval in days, the radius of the search around the wind turbine, the years spanning the searches for carcasses, and the number of megawatts generated by the wind turbines that were sampled.

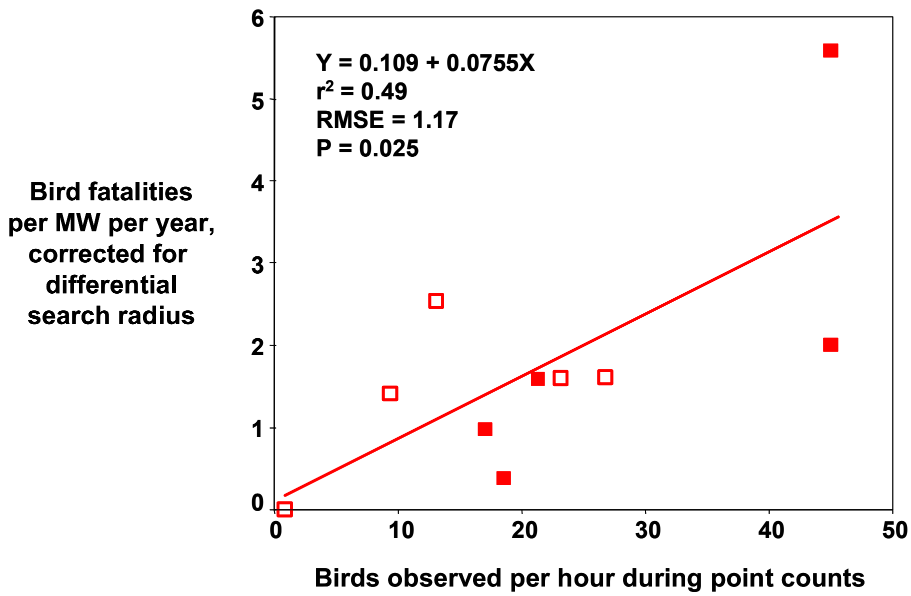

Figure 4-1. Mortality estimates for all birds related positively but not significantly to the number of birds seen per hour during point counts. Solid symbols represent estimates made in the APWRA, and open symbols represent estimates made at other project sites.

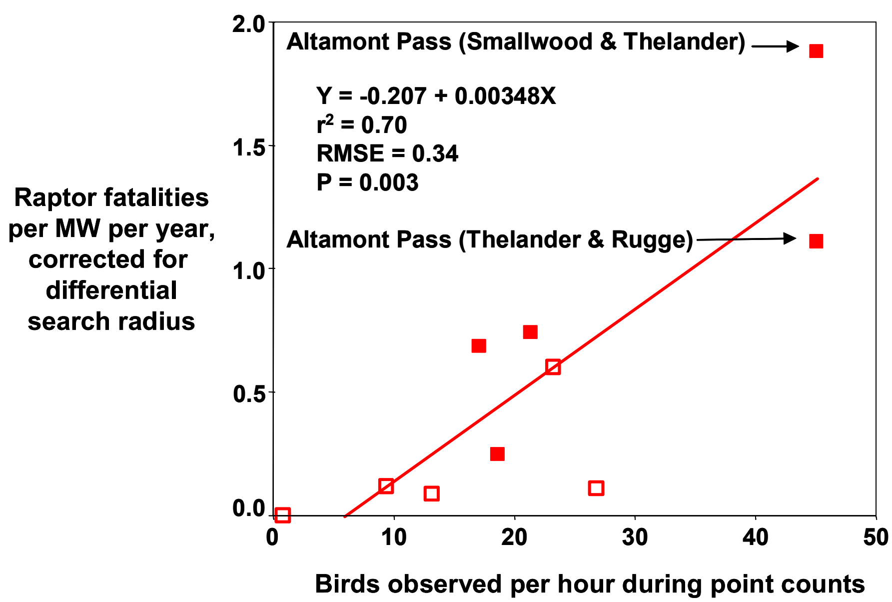

Figure 4-2. Mortality estimates for raptors related positively and significantly to the number of birds seen per hour during point counts. Solid symbols represent estimates made in the APWRA, and open symbols represent estimates made at other project sites.

Our most recent estimate of bird mortality in the APWRA was larger than the mean among estimates reported among all project sites in the United States (Figure 4-3A). Our most recent estimate of raptor mortality in the APWRA was about three times the size of the mean among all project sites (Figure 4-3B). The rate of fatalities appears to be higher in the APWRA than at most other wind energy generating facilities studied to date.

Relative to bird use of the project sites, the most recent mortality estimate for all birds in the APWRA was twice the mean of mortality at all U.S. project sites (Figure 4-4A), and the most recent mortality estimate for raptors in the APWRA was very near the mean of all project sites compared (Figure 4-4B). The risk of wind turbine-caused bird mortality was greater in the APWRA than at most other wind energy generating facilities, whereas the risk of wind turbine-caused raptor mortality was about the same as the average among wind energy generating facilities.

Both bird and raptor mortality in the APWRA tended to increase with the number of birds seen per hour at the project site (Figure 4-5A), although neither regression slope was significantly different from zero. However, raptor mortality in the APWRA tended to decrease with increasing rate of observations of raptors (Figure 4-5B). Bird mortality in the APWRA tended to increase from 1988 through 2000 (Figure 4-6A) , and so did raptor mortality (Figure 4-6B), although neither regression slope was statistically significant from zero.

The number of bird observations per hour increased from 1988 through 2000; whereas, the number of raptor observations did not (Figure 4-7A). The risk index (mortality divided by individuals counted per hour) of birds in the APWRA did not change significantly over these years; whereas, that of raptors increased substantially (Figure 4-7B). No comparable data exist to test whether the risk of bird collisions has changed through time at other wind energy generating facilities.

4.4 DISCUSSION

4.4.1 APWRA Impacts Relative to Other Wind Energy Generating Facilities

The assertion that the APWRA is anomalous in its bird mortality is largely untrue. It appears true for raptor mortality at face value, but factoring in relative raptor abundance clarifies that the impact is relative to the local abundance. The impacts in the APWRA are nearly equal to impacts elsewhere relative to local abundance. Whereas the available data suggest that the APWRA kills more raptors than do other wind energy generating facilities, the risk index demonstrates that the APWRA kills no more raptors *relative to the number seen per hour* than do most other wind energy facilities. Adjusting for local relative abundance, the existing data indicate that most wind energy generating facilities have an equal impact on the local raptors.

This result highlights the need for monitoring bird activity levels at wind energy facilities, in addition to conducting carcass searches. It would be misleading for researchers to conclude that a wind energy facility had only a slight impact on species X because it killed only two members of that species when only those two individuals were present at the wind farm. The real impact would be a complete removal of that species from the area encompassing the wind farm, which would be a strong adverse impact, locally. Absolute numbers are insufficient for concluding impact; relative abundance must be taken into consideration to fairly assess local impact.

Taking relative abundance into consideration, it is important to point out that despite lower levels of raptor use, the raptor risk index has increased substantially in the APWRA since 1988 (Figure 4-7B). Whereas raptor mortality has remained relatively unchanged since 1988 (Figure 4-6B), raptors might have slightly reduced their occurrence in the APWRA during this time (Figure 4-7A) for reason(s) we cannot determine. A larger proportion of those raptors visiting the APWRA are now being killed by the wind turbines.

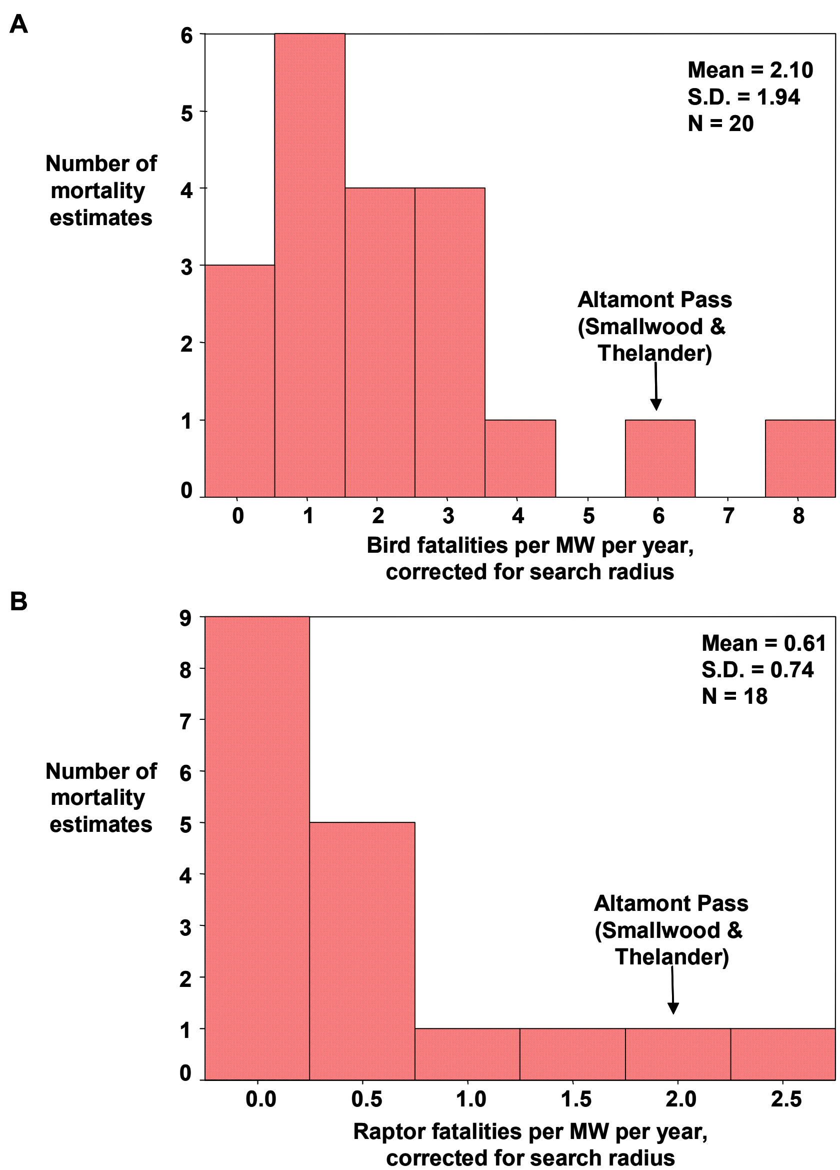

Figure 4-3. Bird mortality in the APWRA was nearly three times the mean of all reported estimates (A), and so was raptor mortality (B).

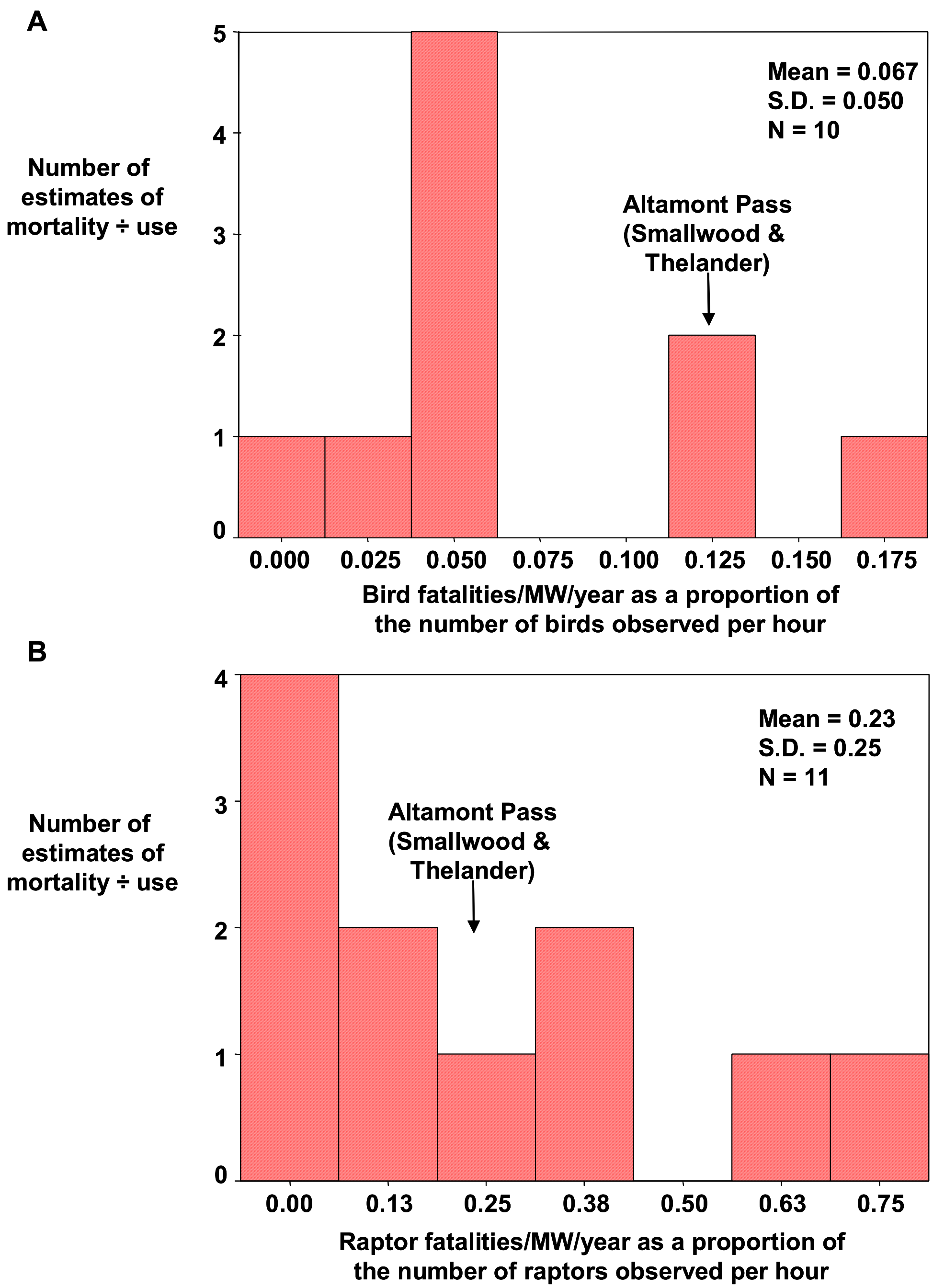

Figure 4-4. Estimates of the risk index, or the mortality divided by the birds seen per hour of point counts, were more platykurtic in distribution than were estimates of mortality alone, and the risk index of all birds in the APWRA was twice the mean among all reports (A) and that of raptors in the APWRA was close to mean among all reports (B).

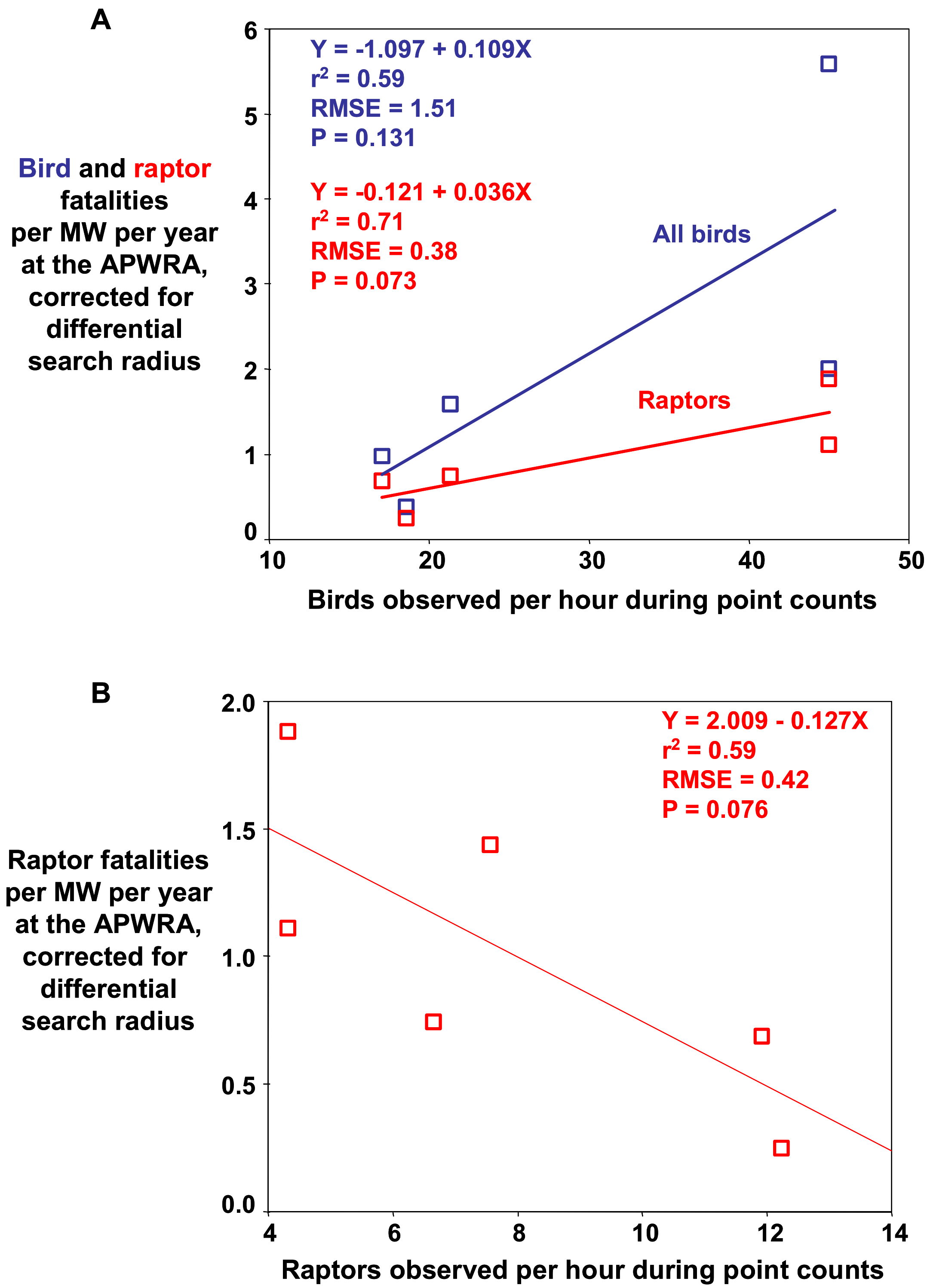

Figure 4-5. The mortality of all birds and raptors tended to increase with the rate of bird observations per hour during point counts (A), whereas the mortality of raptors tended to decline with increasing number of raptors seen per hour of point counts (B). All symbols represent reported estimates of mortality derived from the APWRA during the past 15 years.

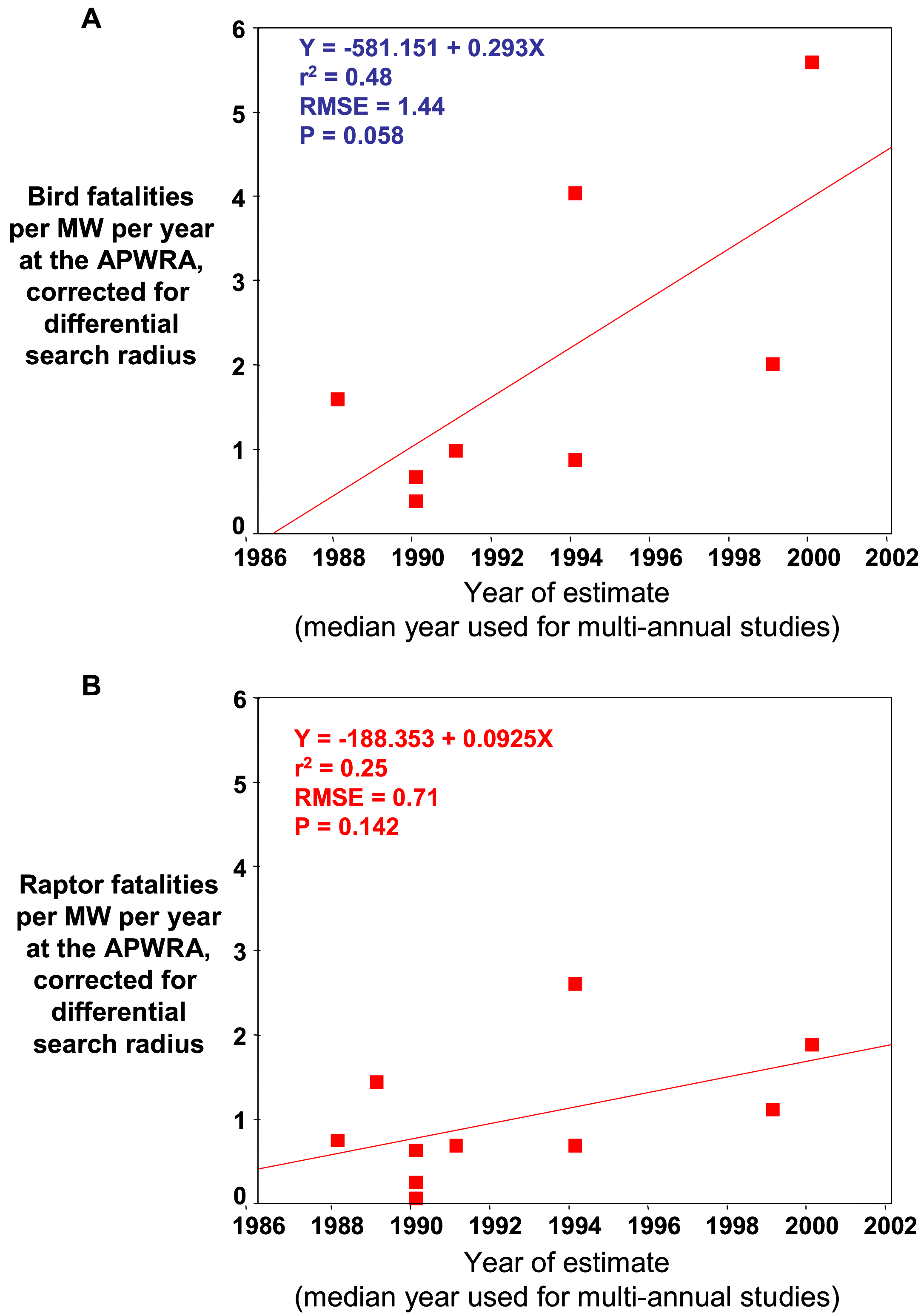

Figure 4-6. Mortality estimates of birds (A) and raptors (B) have tended to increase through time in the APWRA, though not significantly.

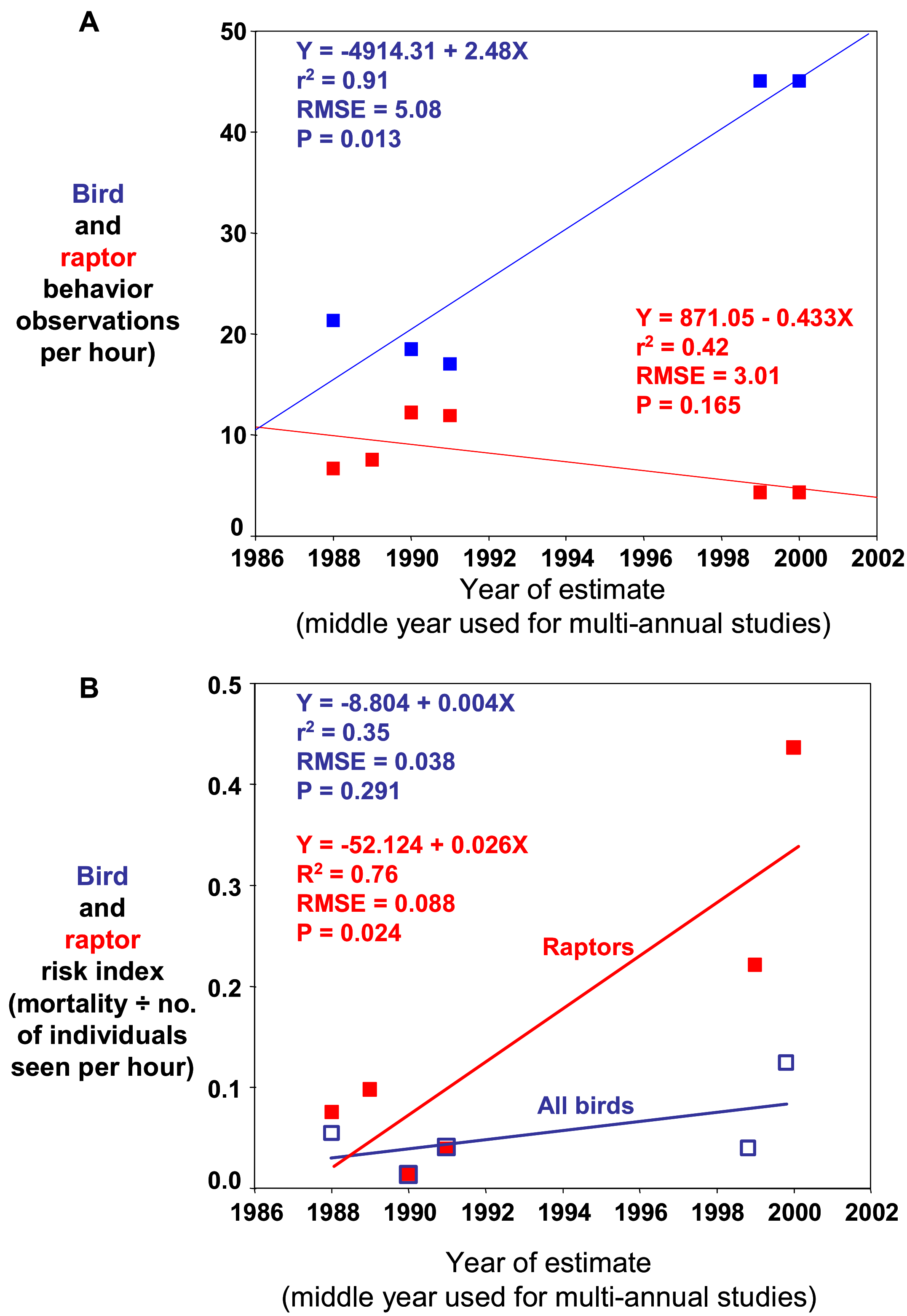

Figure 4-7. Bird observations per hour increased over the past 15 years in the APWRA, whereas raptor observations per hour did not (A), and the risk of death by wind turbine collision remained unchanged for birds but increased for raptors (B).

4.4.2 Reporting Shortfalls

Searcher detection rates and scavenging rates are rarely reported in published results of wind energy-caused bird mortality studies. When they are reported, they lack the standardization necessary for useful comparisons. Also, the reported search radii are too short in many of the studies. The search radius needs to be expanded in relation to the size of the turbines being surveyed, with a minimum of 70 meters used for even the shortest of turbines currently in operation. Finally, more of the bird mortality studies need to account for the mortality caused by facilities other than the wind turbines. Study reports often exclude wire strikes, vehicle collisions, greasing of birds in wind turbines, and electrocutions on distribution poles. These fatalities are all part of the impact of the wind farm and need to be included in estimates of mortality.

Bird use of the wind farm should be measured along with every mortality estimate made. Measuring mortality in the absence of bird use at a wind energy site is almost meaningless, because local conditions are not addressed in the mortality estimate. When measuring bird use of the site, it is important to standardize methods. Point counts need to last sufficiently long to represent bird use, and should be replicated often and over each season of the year and period of the day. Some reports have presented bird use as the mean number of birds seen per five minutes, some per ten minutes, and some per 30 minutes. All reported estimates should be standardized to a per-hour basis so that the risk index is not too large. Also, sufficient sample sizes are important to prevent the generation of risk estimates composed of means near zero and standard deviations much larger than the mean. In other words, it is important to generate and use reliable, robust risk estimates, which are indicated by standard deviations being smaller than the means.

As of January 2004, the American Wind Energy Association (AWEA) reports that the wind-energy generating capacity in the United States totals 6,374 MW. Relying on the most recent estimate from each of nine study sites (wind energy generating facilities), we estimated the weighted mean mortality of birds to be 5.45 deaths/MW/year, and the weighted estimate of raptor mortality from seven study sites was 1.74 deaths/MW/year (two sites reported bird mortality but not raptor mortality). At 6,374 MW of capacity, and assuming the weighted mean mortality among studies is representative of mortality among all U.S. wind energy generating facilities, one can expect that about 35,000 bird fatalities per year would occur, of which about 11,000 would be raptor fatalities. AWEA also reports that the current wind generating capacity is about 1/300th of the estimated potential capacity in the United States. To meet this projection while avoiding killing large numbers of birds will require robust before-construction surveys and avoidance of high bird-use areas.

These mortality estimates for wind power generation, expressed in terms of MW, can be compared to those of other forms of energy generation. By converting MWs to the average number of households served, researchers will be better able to compare bird mortalities caused by various human activities in order to assess the relative impacts of these activities. Of course, these comparisons still do not address local conditions, such as inherent levels of rarity or regional congregations of birds at migration pathways.